Global Model Number (GMN) Check Character Pair Calculation for regulated healthcare medical devices

The GS1 Global Model Number (GMN) is the GS1 identification key used to identify a product model or product family based on attributes common to the model or family as defined by industry or regulation. This GS1 identification key, once assigned to one product model or product family, SHALL NOT be reissued to another. The GMN SHALL NOT be used to identify a trade item. The accommodating structure of the GMN incorporates an optional check character pair and a maximum length of 30 character to meet business sectors and regulatory requirements.

For regulated healthcare medical devices, the GMN is the GS1 identification key to support the implementation of the Basic UDI-DI requirements.

GMN length and structure for regulated healthcare medical devices

For regulated healthcare medical devices, the length and the structure to of the Basic UDI-DI (GMN) (depicted in Figure 1) leverages the GS1 Company Prefix, to connect the device to a brand owner in the GS1 system and enables the brand owners to use more than 4×10^{30} (> 4 Nonillion) internal model references.

FIGURE 1. Format of the Basic UDI-DI (GMN) per EU regulations

Global Model Number (GMN)		
GS1 Company Prefix $\longrightarrow$	Model reference $\longrightarrow$	Check characters
N_1 ... N_i	X_{i+1} ... variable length $X_{j\ (j<=23)}$	$X_{j+1}\ X_{j+2}$

N   numeric digit
X   any character in GS1 AI encodable character set
N3   3 numeric digits, predefined length
N..3   up to 3 numeric digits
X..3   up to 3 characters in GS1 AI encodable character set

GS1 uses a defined subset of the international standard ISO/IEC 646 (See Character set in Table 1). This subset is extensively used in GS1 system to enable the interoperability of Application Identifiers (AIs). The GS1 AI encodable character set has 82 characters comprised of alphanumeric and common special characters. By limiting the character set GS1 reduces common keying errors like adding a "space" key at the end of a character string or not globally recognised special characters like "§" that could be confused for "S" and is not included in the ISO/IEC 646 character set.

Check character pair calculation for regulated healthcare medical devices

GS1's check character algorithm design uses well established modulo calculations and leverages increasing weighted prime numbers to calculate a unique character pair per GMN. GS1's check character, based on a MOD 1021,32 algorithm to calculate the check character pair for use in alphanumeric data structures. The check character pair utilizes uppercase alpha and numeric characters (see TABLE 2 Check character reference values). The check character set further reduces potential keying errors by removing 0, O and 1, I (similar looking numeric alpha characters) from the possible results. The check character pairing also becomes more readily recognised due to the

uppercase alpha numeric character structure. The check character pair enables the detection of various keying and encoding errors, including but not limited to:

- Character substitution(s)
- Character transposition(s)
- Character jump transposition(s)
- Logical shifts
- Character addition(s)
- Character omission(s)

Check character calculation steps:

- **Calculation step 1:** For each character, retrieve the assigned reference value from TABLE 1
- **Calculation step 2:** Each symbol character position is given a prime number weight. Beginning with the right most non-check character (X_j) and progressing left to first character (N_1) the prime weight increases 2, 3, 5, 7, 11, 13, to n; "n" denotes the number of characters representing data not including the check character pair.
- **Calculation step 3:** Multiply each assigned reference value (from step 1) by the weight (from step 2).
- **Calculation step 4:** Total the results of the calculations in step 3.
- **Calculation step 5:** Perform a MOD 1021 on the sum of the products (step 4).
- **Calculation step 6:** The result of step 5 is the check character's reference value.
- **Calculation step 7:** Based on the check character's reference value (C_k), determine the GMN check character using the following:
  - a) $C_k = C_1 * 32 + C_2$, (C_1, C_2 are the assigned reference values for TABLE 2)
    - i. $C_1 = INT (C_k / 32)$, (the whole number to the left of the decimal)
    - ii. $C_2 = C_k - C_1*32$ or $C_2 = C_k$ MOD 32
  - b) Retrieve the alphanumeric characters for X_{j+1} and X_{j+2} using C_1 and C_2

TABLE 1. GS1 AI encodable character reference values

Character set	Assigned value		Character set	Assigned value		Character set	Assigned value
!	0		B	30		e	60
"	1		C	31		f	61
%	2		D	32		g	62
&	3		E	33		h	63
'	4		F	34		i	64
(	5		G	35		j	65
)	6		H	36		k	66
*	7		I	37		l	67
+	8		J	38		m	68
,	9		K	39		n	69
-	10		L	40		o	70

Character set	Assigned value		Character set	Assigned value		Character set	Assigned value
.	11		M	41		p	71
/	12		N	42		q	72
0	13		O	43		r	73
1	14		P	44		s	74
2	15		Q	45		t	75
3	16		R	46		u	76
4	17		S	47		v	77
5	18		T	48		w	78
6	19		U	49		x	79
7	20		V	50		y	80
8	21		W	51		z	81
9	22		X	52			
:	23		Y	53			
;	24		Z	54			
<	25		_	55			
=	26		a	56			
>	27		b	57			
?	28		c	58			
A	29		d	59			

TABLE 2. Check character reference values

Character	Assigned value		Character	Assigned value		Character	Assigned value
2	0		D	11		Q	22
3	1		E	12		R	23
4	2		F	13		S	24
5	3		G	14		T	25
6	4		H	15		U	26
7	5		J	16		V	27
8	6		K	17		W	28
9	7		L	18		X	29
A	8		M	19		Y	30
B	9		N	20		Z	31
C	10		P	21			

Example of a check character calculation (based on 25 character Global Model Number)

Position	P_1	P_2	P_3	P_4	P_5	P_6	P_7	P_8	P_9	P_{10}	P_{11}	P_{12}	P_{13}	P_{14}
GMN	1	9	8	7	6	5	4	A	d	4	X	4	b	L

Position	P_1	P_2	P_3	P_4	P_5	P_6	P_7	P_8	P_9	P_{10}	P_{11}	P_{12}	P_{13}	P_{14}
Assigned value	14	22	21	20	19	18	17	29	59	17	52	17	57	40
Multiply by Weight	X 83	X 79	X 73	X 71	X 67	X 61	X 59	X 53	X 47	X 43	X 41	X 37	X 31	X 29
Results to sum	1162	1738	1533	1420	1273	1098	1003	1537	2773	731	2132	629	1767	1160

Example of a check character calculation for 25-character GMN continued

Position	P_{15}	P_{16}	P_{17}	P_{18}	P_{19}	P_{20}	P_{21}	P_{22}	P_{23}	P_{24}	P_{25}
GMN	5	t	t	r	2	3	1	0	c	**2**	**K**
Assigned value	18	75	75	73	15	16	14	13	58		
Multiply by weighting factor	X 23	X 19	X 17	X 13	X 11	X 7	X 5	X 3	X 2		
Results to sum	414	1425	1275	949	165	112	70	39	116		

Summary totals	
Sum weighted assigned values	24521
MOD **1021** for the Sum weighted assigned values	17
Integer Results of MOD **1021** Sum weighted assigned values divided by 32	**0**
Remainder of MOD 1021 Sum weighted assigned value multiplied by 32	**17**
Check character for position P_{24} referenced from table 2	**2**
Check character for position P_{25} referenced from table 2	**K**

GS1 Standards glossary of terms

GS1 glossary of terms and definitions

The glossary lists the terms and definitions that are applied in this document. Please refer to the *www.gs1.org/glossary* for the online version.

Term	Definition
Basic UDI-DI	The Basic UDI-DI is a unique identifier specific to a medical device product family . It is represented by GS1's Global Model Number (GMN).
check character pair	A final character pair calculated from the other characters of some GS1 identification keys. These characters are used to check that the data has been correctly composed.
GS1 check character calculation	An algorithm used by the GS1 system for the calculation of the check characters to verify accuracy of data.
Global Model Number (GMN)	The GS1 identification key used to identify a product model or product family. The key comprises a GS1 Company Prefix and model reference.
model reference	A component of the Global Model Number (GMN) assigned by the brand owner to create a unique GMN.
modulo	The modulo (also known as modulus) operation determines the remainder after division of one number by another. Given two positive numbers, "Y" (the dividend) and "Z" (the divisor), Y modulo Z (abbreviated as Y MOD Z) is the remainder of the Euclidean division of Y by Z.

GS1 abbreviations

Abbreviation	Term
GMN	Global Model Number
INT	Integer
MOD	Modulo
UDI-DI	Unique Device Identification – Device Identifier